

Appendix A

Lewis Curriculum Vitae

APPENDIX A

CURRICULUM VITAE

NAME: Michael Edward Lewis, Ph.D.

BIRTHDATE: November 9, 1951

BIRTHPLACE: Chicago, IL

HOME ADDRESS: 1007 Saber Road
West Chester, PA 19382

MARITAL STATUS: Married, two children

Wife Jill M. Roberts-Lewis, Ph.D.

EDUCATION:

B.A., 1973 The George Washington University (Psychology)
Washington, D.C.

M.A., 1975 Clark University (Psychology)
Worcester, MA

Thesis Title: The Influence of Early Experience on the
Effects of One- and Two-Stage Hippocampal Lesions in
Male Rats

Ph.D., 1977 Clark University (Psychology)
Worcester, MA

Dissertation Title: Nerve Growth Factor and Recovery of
Function after Brain Damage

POSITIONS HELD:

1972-1973 Psychology Technician, Section on Neuropsychology,
Laboratory of Psychology, National Institute of Mental
Health, Bethesda, MD

1973-1977 Graduate Student and Teaching Assistant, Clark
University, Worcester, MA

1977 Guest Worker, Section on Growth Factors, National
Institute of Child Health and Human Development, NIH,
Bethesda, MD

1977-1978	Supervisor of Part II (advanced undergraduate) students, University of Cambridge, Cambridge, England
1977-1979	Research Fellow, The Physiological Laboratory, and The Psychological Laboratory, University of Cambridge, England
1979	Instructor, European Division, University College, University of Maryland, RAF Bentwaters, Suffolk, England
1980	Research Psychologist (GS-11), Section on Biochemistry and Pharmacology, Biological Psychiatry Branch, National Institute of Mental Health, Bethesda, MD
1980-1981	Research Psychologist (GS-12), Division of Research, National Institute on Drug Abuse, Rockville, MD
1981-1985	Research Investigator, Mental Health Research Institute, The University of Michigan, Ann Arbor, MI
1985-1987	Principal Scientist, Central Research and Development Department and Medical Products Department, E.I. du Pont de Nemours & Co., Experimental Station, Wilmington, DE
1986-1987	Visiting Associate Professor of Pharmacology, Department of Pharmacology, Medical College of Pennsylvania, Philadelphia, PA
1988-1989	Co-Founder and Senior Scientist, Cephalon, Inc., West Chester, PA (IPO 1991; CEPH: NASDAQ)
1989-1992	Director of Pharmacology, Cephalon, Inc., West Chester, PA
1992-1993	Senior Director of Scientific Affairs, Cephalon, Inc., West Chester, PA
1993-1994	Vice President of Research, Symphony Pharmaceuticals, Inc., Malvern, PA
1994-	President, BioDiligence Partners, Inc., West Chester, PA
1994-1997	Co-Founder and Chief Scientific Advisor, Adolor Corporation, Malvern, PA (IPO 2000; ADLR: NASDAQ)
1997-	Co-Founder and Chief Scientific Advisor, Arena Pharmaceuticals, Inc., San Diego, CA (IPO 2000; ARNA:NASDAQ)

HONORS, AWARDS AND FELLOWSHIPS:

1973	Graduated from The George Washington University with Special Honors in Psychology
1974	Honorable Mention, National Science Foundation, Washington, D.C.
1977-1979	Felix and Elizabeth Brunner Award, Mental Health Foundation, London, England
1979	Wellcome Research Fellowship, The Wellcome Trust, London, England
1979	Twinning Grant (with Professor A. Bjorklund, University of Lund), European Training Program in Brain and Behavior Research, European Science Foundation, Strasbourg, France
1981-1982	John G. Searle Clinical Pharmacology Fellowship
1982-1985	National Research Service Award, USPHS
1989	Small Business Innovative Research Grant, Phase I, NIMH, MHSB 1 R43 MH44950-01A1, "Non-radioactive Detection of Receptors in Brain".
1990	Small Business Innovative Research Grant, Phase I, NIMH, MHSB 1 R43 MH44957-01A1, "Non-radioactive Hybridization of Brain RNA".
1992	Small Business Innovative Research Grant, Phase II, NIMH, MHSB 2 R44 MH44957-02, "Non-radioactive Hybridization of Brain RNA".

PROFESSIONAL SOCIETY MEMBERSHIPS:

Division of Medicinal Chemistry, ACS
Division of Organic Chemistry, ACS
International Brain Research Organization
Society for Neuroscience

JOURNAL REFEREE:

Biochemical Pharmacology
Brain Research
Endocrine Journal
Endocrinology
Experimental Neurology
Journal of Neuroscience Methods
Molecular and Cellular Neurosciences
Neurochemistry International
Neuroscience
Peptides
Proceedings of the National Academy of Sciences
Science

GRANT AND CONTRACT REVIEWER:

National Institute on Drug Abuse
National Institute of Mental Health
National Science Foundation
Veterans Administration Research Program

CONFERENCE ORGANIZING COMMITTEES:

Du Pont Workshop on Computer-aided Data Acquisition and Integration in Neuroanatomy, March 19-20, 1986.

International Conference on Chemically Induced Neurotoxicity: Concepts, Criteria, and Methods, Dampierre-en-Yvelines, France, July 1990.

MAJOR DRUG DISCOVERY/DEVELOPMENT ACTIVITIES (CEPHALON):

Myotrophin (IGF-I) Program

- o Supervised initial discovery research on IGF-I for motor neuron diseases
- o Lead inventor on issued U.S. and pending foreign patents for use of IGF-I in treating amyotrophic lateral sclerosis; co-wrote application
- o Initiated testing of IGF-I in peripheral neuropathy models with collaborators
- o Lead inventor on issued U.S. and pending foreign patents for use of IGF-I in treating peripheral neuropathy; co-wrote application
- o Contributed to writing of document to obtain orphan drug designation from FDA; filed in 1992, approved in 1992; created "Myotrophin" name for IGF-I
- o Contributed to writing of pre-IND document for FDA
- o Presented IGF-I efficacy data to FDA in pre-IND meeting
- o Contributed to writing IND; filed in 1992, approved in 1993
- o Participated in regular Myotrophin team meetings (clinical plans/strategy)

- o Responsible for presenting Myotrophin data at clinical neurology meetings

Receptor Tyrosine Kinase Effector Program

- o Supervised initial discovery research in receptor tyrosine kinase program
- o Lead inventor on issued U.S. and pending foreign patents for CEP-075 and CEP-1347; co-wrote application

Cerebral Ischemia Program

- o Supervised cerebral ischemia research program
- o Co-inventor on issued U.S. patent; co-wrote application

Neurotrophic Factor-Enhancing Molecule Program

- o Presented proposed program to Schering-Plough management prior to establishment of corporate relationship
- o Established and supervised research program
- o Presented program progress updates to Schering-Plough management
- o Co-inventor on pending patents; co-wrote application

Retinopathy Therapeutics Program

- o Co-inventor on pending patents; co-wrote application

Prostate Cancer Therapeutics/Diagnostics

- o Co-inventor on pending patents; co-wrote application

MAJOR CORPORATE SUPPORT ACTIVITIES (CEPHALON):

- o Prepared application for NRC Radioactive Materials License; application approved in 1988
- o Assisted in writing technical section of Prospectus for Initial Public Offering
- o Responsible for road show presentations in Japan for Initial Public Offering (\$59.4 million)
- o Responsible for technical portion of road show presentations of Cephalon Clinical Partners, L.P. private placement (\$45 million)
- o Regularly met with brokerage analysts for due diligence
- o Created and managed the Scientific Affairs group, with responsibility for timely identification and analysis of new technologies which could enhance, complement, or compete with existing research programs

MAJOR DRUG DISCOVERY/DEVELOPMENT ACTIVITIES (SYMPHONY):

- o Responsible for overall management of research programs
- o Participated in ACPC Development Meetings
- o Participated in ACPC pre-IND meeting with FDA
- o Researched and identified potential surrogate marker for Phase I
- o Researched and proposed initial Phase II indication for ACPC
- o Identified and contacted lead clinical investigator for Phase II

MAJOR CORPORATE SUPPORT ACTIVITIES (SYMPHONY):

- o Supervised preparation of application for NRC Radioactive Materials License; application approved in 1994
- o Prepared Technology Summary Document for potential corporate partners
- o Responsible for presenting technical portion of slide show to potential investors
- o Responsible for providing technical due diligence information and position papers to potential investors

MAJOR DRUG DISCOVERY/DEVELOPMENT ACTIVITIES (ADOLOR):

- o Co-inventor on ADL 2-1294 patent application; assisted in preparation
- o Participated in ADL 2-1294 Development Meetings
- o Researched and identified Phase Ib clinical surrogate indicator for ADL 2-1294
- o Researched and proposed initial Phase II indication for ADL 2-1294
- o Assisted in writing pre-IND document for ADL 2-1294

MAJOR CORPORATE SUPPORT ACTIVITIES (ADOLOR):

- o Assisted in recruiting CEO and initial investors (\$1.5 million)
- o Primary responsibility for writing business plan
- o Assisted in presentation of company technology to potential follow-on investors
- o Responsible for providing technical due diligence information and position papers to follow-on investors (\$9.6 million, 1996; \$9.7 million, 1997)
- o Assisted in presentation of company technology to potential corporate partners

CURRENT ACTIVITIES:

- o Co-Founder and Chief Scientific Advisor, Arena Pharmaceuticals (80% commitment)
- o Private consulting (20% commitment)

BIOGRAPHY:

Who's Who in Science and Engineering, 1992-1993, p. 508

BOOK EDITED:

Brain Imaging: Techniques and Applications, N.A. Sharif and M.E. Lewis, eds., Ellis Horwood Ltd., Chichester, England. 1989.

ISSUED U.S. PATENTS:

Lewis, M.E., Kauer, J.C., Smith, K.R., Callison, K.V. and Baldino, F., Jr. Treating disorders by application of insulin-like growth factor. U.S. 5,093,317 (patent for Myotrophin - amyotrophic lateral sclerosis indication, for which two Phase III trials were completed; provisional FDA approval pending further development).

Lewis, M.E., Apfel, S.C. and Kessler, J.A. Prevention and treatment of peripheral neuropathy. U.S. 5,420,112 (patent for Myotrophin - chemotherapy-induced peripheral neuropathies).

Roberts-Lewis, J.M. and Lewis, M.E. Treatment of neurological disorders. U.S. 5,430,039 (patent for small molecule stroke therapeutic).

Lewis, M.E., Kauer, J.C., Neff, N., Roberts-Lewis, J., Murakata, C., Saito, H., Matsuda, Y. and Glicksman, M.A. Selected protein kinase inhibitors for the treatment of neurological disorders. U.S. 5,461,146 (patent for small molecule compounds in CEP-1347 class, expected to enter clinical development for Alzheimer's disease).

Lewis, M.E., Apfel, S.C. and Kessler, J.A. Prevention and treatment of peripheral neuropathy. U.S. 5,569,648 (patent for Myotrophin - toxic neuropathy indications).

Lewis, M.E., Kauer, J.C., Neff, N., Roberts-Lewis, J., Murakata, C., Saito, H., Matsuda, Y. and Glicksman, M.A. K252a derivatives for the treatment of neurological disorders. U.S. 5,621,100 (patent for compounds in CEP-1347 class).

Lewis, M.E., Kauer, J.C., Neff, N., Roberts-Lewis, J., Murakata, C., Saito, H., Matsuda, Y. and Glicksman, M.A. Protein kinase inhibitors for the treatment of neurological disorders. U.S. 5,621,101 (patent for compounds in CEP-1347 class).

Lewis, M.E., Apfel, S.C. and Kessler, J.A. Prevention and treatment of peripheral neuropathy. U.S. 5,633,228 (patent for Myotrophin - post-polio syndrome indication; preliminary Phase II study conducted).

Lewis, M.E., Apfel, S.C. and Kessler, J.A. Prevention and treatment of peripheral neuropathy. U.S. 5,648,335 (patent for Myotrophin - hereditary neuropathy indications).

Lewis, M.E., Kauer, J.C., Smith, K.R., Callison, K.V. and Baldino, F., Jr. Treating disorders by application of insulin-like growth factor. U.S. 5,652,214 (patent for Myotrophin - broad central neurological indications, with dose range limits).

Lewis, M.E., Kauer, J.C., Smith, K.R., Callison, K.V., Baldino, F., Jr., Neff, N. and Iqbal, M. Treating disorders by application of insulin-like growth factor. U.S. 5,703,045 (patent for IGF-II - broad central neurological indications).

Lewis, M.E., Kauer, J.C., Neff, N., Roberts-Lewis, J., Murakata, C., Saito, H., Matsuda, Y., Glicksman, M.A., Kanai, F. and Kaneko, M. Protein kinase inhibitors for the treatment of neurological disorders. U.S. 5,741,808 (patent for compounds in CEP-1347 class).

Lewis, M.E., Kauer, J.C., Neff, N., Roberts-Lewis, J., Murakata, C., Saito, H., Matsuda, Y., Glicksman, M.A., Kanai, F. and Kaneko, M. Protein kinase inhibitors for the treatment of neurological disorders. U.S. 5,756,494 (patent for compounds in CEP-1347 class).

Lewis, M.E., Kauer, J.C., Smith, K.R., Callison, K.V., Baldino, F., Jr., Neff, N. and Iqbal, M. Treating disorders by application of insulin-like growth factor. U.S. 5,776,897 (patent for Myotrophin - broad central neurological indications, without dose range limits).

PUBLISHED PATENT APPLICATIONS:

Lewis, M.E., Kauer, J.C., Smith, K., Callison, K.V. and Baldino, F., Jr. Treating disorders by application of insulin-like growth factors and analogs. WO 90/14838. Issued in Japan, Patent Pub. No. 68138/95.

Bozyczko-Coyne, D., Neff, N., Lewis, M. E., and Iqbal, M. Treating retinal neuronal disorders by the application of insulin-like growth factors and analogs. WO 93/08826.

Lewis, M.E., Kauer, J.C., Smith, K., Callison, K.V. and Baldino, F., Jr., Neff, N. and Iqbal, M. Treating disorders by application of insulin-like growth factors and analogs. WO 93/20836.

Lewis, M.E., Apfel, S.C. and Kessler, J.A. Prevention and treatment of peripheral neuropathy. WO 93/25219.

Lewis, M.E., Neff, N., Roberts-Lewis, J., Murakata, C., Saito, H., Matsuda, Y. and Kauer, J.C. Bis-staurosporine and K-252a derivatives. WO 94/02488.

Djakiew, D. and Lewis, M.E. A method for the detection and treatment of prostate disease. WO 94/06935.

Hoffman, E., Carswell, S. and Lewis, M.E. Method for identifying compounds that induce an increased level of the nerve growth factor mRNA. WO 94/19461.

Yaksh, T.L., Farrar, J.J., Maycock, A.L., Lewis, M.E. and Dow, G.J. Peripherally active

anti-hyperalgesic opiates. WO9709973-A2

PUBLICATIONS:

Lewis, M.E. and Stein, D.G.: Pattern discrimination after lesions of the visual cortex (letter). Science, 190: 914-915, 1975

Isseroff, A., Leveton, L., Freeman, G., Lewis, M.E. and Stein, D.G.: Differences in the behavioral effects of single stage and serial lesions of the hippocampus. Exp. Neurol., 53: 339-354, 1976.

Lewis, M.E. and Lancione, R.L.: A mathematical model of recovery from brain damage. Brain Theory Newsletter, 1: 65-66, 1976.

Lewis, M.E., Lakshmanan, J., Nagaiah, K., MacDonnell, P.C. and Guroff, G.: Nerve growth factor increases activity of ornithine decarboxylase in rat brain. Proc. Natl. Acad. Sci. USA, 75: 1021-1023, 1978.

Lewis, M.E., Avrith, D.B. and Fitzsimons, J.T.: Short latency drinking and markedly increased Na appetite following intracerebral microinjection of NGF in the rat. Nature, 279: 440-442, 1979.

Lewis, M.E., Brown, R.M., Brownstein, M.J., Hart, T. and Stein, D.G.: Nerve growth factor: effects on d-amphetamine-induced activity and brain monoamines. Brain Res., 176: 297-310, 1979.

Sahgal, A., Iversen, S.D., Lewis, M.E. and Trimnell, L. Effects of ACTH on a conflict schedule in pigeons. Comm. Psychopharmacol., 3: 211-216, 1979.

Avrith, D.B., Lewis, M.E. and Fitzsimons, J.T.: Renin-like effects of NGF evaluated using renin-angiotensin antagonists. Nature, 285: 248-250, 1980.

Bjorklund, A., Dunnett, S.B., Stenevi, U., Lewis, M.E. and Iversen, S.D.: Reinnervation of the denervated neostriatum by substantia nigra transplants: functional consequences as revealed by pharmacological and sensorimotor testing. Brain Res., 199: 307-333, 1980.

Guroff, G., Montgomery, P., Tolson, N., Lewis, M.E. and End, D.: The induction of ornithine decarboxylase by renin-free nerve growth factor. Proc. Natl. Acad. Sci. USA, 77: 4607-4609, 1980.

Lewis, M.E., Avrith, D.B. and Fitzsimons, J.T.: Polydipsia after injections--a property of NGF or a contaminant? Reply. Nature, 284: 577, 1980.

LeRoith, D., Shiloach, J., Roth, J., Liotta, A.S., Krieger, D.T., Lewis, M.E. and Pert, C. B: Evolutionary origins of vertebrate hormones: Material very similar to adrenocorticotrophic hormone, beta-endorphin and dynorphin in protozoa. Trans. Ass. Am. Phys., 94: 52-60, 1981.

Lewis, M.E., Mishkin, M., Bragin, E., Brown, R.M., Pert, C.B. and Pert, A.: Opiate receptor gradients in monkey cerebral cortex: correspondence with sensory processing hierarchies. Science, 211: 1166-1169, 1981.

Lewis, M.E., Patel, J., Moon Edley, S. and Marangos, P.J.: Autoradiographic visualization of rat brain adenosine receptors using N₆-cyclohexyl-[³H]adenosine. Eur. J. Pharmacol., 73: 109-110, 1981.

Khachaturian, H., Lewis, M.E. and Watson, S.J.: Immunocytochemical studies with antisera against leu-enkephalin and enkephalin-precursor fragment (BAM-22P) in the rat brain. Life Sciences, 31: 1879-1882, 1982.

Khachaturian, H., Watson, S.J., Lewis, M.E., Akil, H., Coy, D. and Goldstein, A.: Dynorphin immunocytochemistry in the rat central nervous system, Peptides, 3:941-954, 1982.

LeRoith, D., Liotta, A.S., Roth, J., Shiloach, J., Lewis, M.E., Pert, C.B. and Krieger, D.T.: Corticotropin and beta-endorphin-like materials are native to unicellular organisms. Proc. Natl. Acad. Sci. USA, 79: 2086-2090, 1982.

Lewis, M.E., Khachaturian, H. and Watson, S.J.: Visualization of opiate receptors and opioid peptides in sequential brain sections. Life Sciences, 31: 1347-1350, 1982.

Mishkin, M., Lewis, M.E. and Ungerleider, L.G.: Equivalence of parietopreoccipital subareas for visuospatial ability in monkeys. Behav. Brain Res., 6: 41-55, 1982.

Smith, C.C., Lewis, M.E. and Tallman, J.F.: Effect of benzodiazepines on cyclic GMP formation in rat cerebellar slices. Pharmacol. Biochem. Behav., 16: 29-33, 1982.

Beinfeld, M.C., Lewis, M.E., Eiden, L.E., Nilaver, G., Pert, C.B. and Pert, A.: The distribution of cholecystikinin and vasoactive intestinal peptide in rhesus monkey brain as determined by radioimmunoassay. Neuropeptides., 3: 337-344, 1983.

Khachaturian, H., Lewis, M.E., Holtt, V. and Watson, S.J.: Telencephalic enkephalinergic systems in the rat brain, J. Neurosci., 3: 844-855, 1983.

Khachaturian, H., Lewis, M.E. and Watson, S.J.: Enkephalin systems in diencephalon and brain stem of the rat. J. Comp. Neurol., 220: 310-320, 1983.

Lewis, M.E., Khachaturian, H. and Watson, S.J.: Comparative distribution of opiate receptors and three opioid peptide neuronal systems in rhesus monkey central nervous system. Life Sciences, 33: 239-242, 1983.

Lewis, M.E., Pert, A., Pert, C.B. and Herkenham, M.: Opiate receptor localization in rat cerebral cortex. J. Comp. Neurol., 216: 339-358, 1983.

Khachaturian, H., Lewis, M.E. and Watson, S.J.: Colocalization of proenkephalin peptides in the same neurons in rat brain. Brain Res., 279: 369-373, 1983.

Khachaturian, H., Lewis, M.E., Akil, H. and Watson, S.J.: Proopiomelanocortin peptide immunocytochemistry in rhesus monkey brain. Brain Res. Bull., 13: 785-800, 1984.

Lewis, J. W., Lewis, M.E., Loomus, D.J. and Akil, H.: Acute systemic administration of morphine selectively increases mu opioid receptor binding in the rat brain. Neuropeptides, 5: 117-120, 1984.

Lewis, M.E., Khachaturian, H., Akil, H. and Watson, S.J.: Anatomical relationship between opioid peptides and receptors in rhesus monkey brain. Brain Res. Bull., 13: 801-812, 1984.

Lewis, M.E., Young, E.A., Akil, H., Houghten, R. and Watson, S.J.: Binding of [³H]dynorphin A to apparent kappa opioid receptors in deep layers of guinea pig cerebral cortex. Eur. J. Pharmacol., 98: 149-150, 1984.

Dores, R.M., Lewis, M.E., Khachaturian, H., Watson, S.J. and Akil, H.: Analysis of opioid and non-opioid end products of prodynorphin in the substantia nigra of the rat. Neuropeptides, 5: 501-504, 1985.

Khachaturian, H., Alessi, N.E., Lewis, M.E., Munfakh, N., Fitzsimmons, M. D. and Watson, S.J.: Development of hypothalamic opioid neurons: A combined immunocytochemical and ³H-thymidine autoradiographic study. Neuropeptides, 5: 477-480, 1985.

Khachaturian, H., Lewis, M.E., Alessi, N.E. and Watson, S.J.: Time of genesis of opioid peptide containing neurons in the rat hypothalamus J. Comp. Neurol., 236: 538-546, 1985.

Khachaturian, H., Lewis, M.E., Haber, S. N., Akil, H. and Watson, S.J.: Prodynorphin peptide immunocytochemistry in rhesus monkey brain. Peptides, 6 (Suppl. 2), 155-166, 1985.

Khachaturian, H., Lewis, M.E., Schafer, M. K.-H. and Watson, S.J.: Anatomy of the CNS opioid systems. Trends in Neurosciences, 8: 111-119, 1985.

Lewis, M.E., Khachaturian, H. and Watson, S.J.: Combined autoradiographic-immunocytochemical analysis of opiate receptors and opioid peptide neuronal systems in brain. Peptides, 6 (Suppl. 1), 37-47, 1985.

Lewis, M.E., Sherman, T. G. and Watson, S.J.: In situ hybridization histochemistry with synthetic oligonucleotides: Strategies and methods. Peptides, 6 (Suppl. 2), 75-87, 1985.

Thomas, S. R., Lewis, M.E. and Iversen, S.D.: Correlation of [³H]diazepam binding density with anxiolytic locus in the amygdaloid complex of the rat. Brain Res., 342: 85-90, 1985.

Lewis, M.E., Arentzen, R. and Baldino, F., Jr.: Rapid, high-resolution in situ hybridization histochemistry with radioiodinated synthetic oligonucleotides. J. Neurosci. Res., 16: 117-124, 1986.

Lewis, M.E., Sherman, T.G., Burke, S., Akil, H., Davis, L.G., Arentzen, R., and Watson, S.J.: Detection of proopiomelanocortin mRNA by in situ hybridization

with an oligonucleotide probe. Proc. Natl. Acad. Sci. USA, 83: 5419-5423, 1986.

Mansour, A., Lewis, M.E., Khachaturian, H., Akil, H., and Watson, S.J.: Pharmacological and anatomical evidence of selective mu, delta, and kappa opioid receptor binding in rat brain. Brain Res., 399: 69-79, 1986.

Mansour, A., Lewis, M.E., Khachaturian, H., Akil, H., and Watson, S.J.: Multiple opioid receptor subtypes in the pituitary-adrenal axis: A cross-species study. NIDA Res. Monogr., 75: 311-314, 1986.

Young, E.A., Walker, J.M., Lewis, M.E., Houghten, R., Woods, J.H., and Akil, H.: [³H]Dynorphin A binding and kappa selectivity of prodynorphin peptides in rat, guinea pig and monkey brain. Eur. J. Pharmacol. 121: 355-365, 1986.

Mansour, A., Khachaturian, H., Lewis, M.E., Akil, H., and Watson, S.J.: Autoradiographic differentiation of mu, delta, and kappa opioid receptors in the rat forebrain and midbrain. J. Neurosci., 7: 2445-2464, 1987.

Rogers, W.T., Schwaber, J.S., and Lewis, M.E. Quantitation of cellular resolution in situ hybridization histochemistry in brain by image analysis. Neurosci. Lett., 82: 315-320, 1987.

Mansour, A., Khachaturian, H., Lewis, M.E., Akil, H., and Watson, S.J. Anatomy of the CNS opioid receptors. Trends in Neurosci., 11: 308-314, 1988.

Fitzpatrick-McElligott, S., Card, J. P., Lewis, M.E., and Baldino, F., Jr. Neuronal localization of prosomatostatin mRNA in rat brain with in situ hybridization histochemistry. J. Comp. Neurol., 273: 558-572, 1988.

Lewis, M.E., Krause, R.G. and Roberts-Lewis, J.M. Recent developments in the use of synthetic oligonucleotides for in situ hybridization histochemistry. Synapse, 2: 308-316, 1988.

Baldino, F., Jr., Deutch, A.Y., Roth, R.H., and Lewis, M.E. In situ hybridization histochemistry of tyrosine hydroxylase messenger RNA in rat brain. Ann. N.Y. Acad. Sci., 537: 484-487, 1988.

Ingram, S.M., Krause, R.G., Baldino, F., Jr., Skeen, L.C. and Lewis, M.E., Neuronal localization of cholecystokinin mRNA in the rat brain by using in situ hybridization histochemistry. J. Comp. Neurol., 287:260-272, 1989.

Lewis, M.E., Robbins, E., Grega, D. and Baldino, F., Jr., Nonradioactive detection of vasopressin and somatostatin mRNA with digoxigenin-labeled oligonucleotide probes. Ann. N.Y. Acad. Sci., 579: 246-253, 1990.

Roberts-Lewis, J.M., Cimino, M., Krause, R.G., Tyrrell, D.F., Davis, L.G., Weiss, B. and Lewis, M.E. Anatomical localization of calmodulin mRNA in the rat brain with cloned cDNA and synthetic oligonucleotide probes. Synapse, 5: 247-254, 1990.

Springer, J.E., Robbins, E., Meyer, S., Baldino, F., Jr. and Lewis, M.E. Localization of nerve growth factor receptor mRNA in the rat basal forebrain with

in situ hybridization histochemistry. Cell. Mol. Neurobiol., 10: 33-39, 1990.

Springer, J.E., Robbins, E., Gwag, B.J., Lewis, M.E. and Baldino, F., Jr. Non-radioactive detection of nerve growth factor receptor mRNA in the rat brain using in situ hybridization histochemistry. J. Histochem. Cytochem., 39: 231-234, 1991.

Liu-Chen, L.-Y., Li, S., and Lewis, M.E. Autoradiographic study of irreversible binding of [³H]beta-funaltrexamine to opioid receptors in the rat forebrain - comparison with mu-receptor and delta-receptor. Brain Res., 544: 235-242, 1991.

Robbins, E., Baldino, F., Jr., Roberts-Lewis, J.M., Meyer, S., Grega, D.S., and Lewis, M.E. Quantitative non-radioactive in situ hybridization of preproenkephalin mRNA with digoxigenin-labeled cRNA probes. Anat. Rec., 231: 559-562, 1991.

Carswell, S., Hoffman, E.K., Clopton-Hartpence, K., Wilcox, H.M., and Lewis, M.E. Induction of NGF by isoproterenol, 4-methyl catechol and serum occurs by three distinct mechanisms. Mol. Brain Res., 15, 145-150, 1992.

Robbins, E., Baldino, F., Jr., Roberts-Lewis, J.M., Reilly, E.M., and Lewis, M.E. Enzyme histochemical detection of specific neuronal mRNAs in brain. Cell Physiol. Biochem., 3, 173-180, 1993.

Apfel, S.C., Arezzo, J.C., Lewis, M.E. and Kessler, J.A. The use of IGF-I in the prevention of vincristine neuropathy in mice. Ann N.Y. Acad. Sci., 692, 243-245, 1993.

Lewis, M.E., Vaught, J.L., Neff, N., Grebow, P.E., Callison, K.V., Yu, E. and Baldino, F., Jr. The potential of IGF-I as a therapeutic for the treatment of neuromuscular disorders. Ann. N.Y. Acad. Sci., 692, 201-208, 1993.

Glicksman, M.A., Prantner, J.E., Meyer, J.L., Forbes, M.E., Dasgupta, M., Lewis, M.E. and Neff, N. K252a and staurosporin promote choline acetyltransferase activity in rat spinal cord cultures, J. Neurochem., 61, 210-221, 1993.

Roberts-Lewis, J.M., Marcy, V.R., Zhao, Y., Siman, R., Vaught, J.L. and Lewis, M.E. Aurintricarboxylic acid protects hippocampal neurons from NMDA- and ischemia-induced toxicity in vivo. J. Neurochem., 61, 378-381, 1993.

Saporito, M.S., Wilcox, H.M., Hartpence, K.C., Lewis, M.E., Vaught, J.L. and Carswell, S. Pharmacological induction of nerve growth factor mRNA in adult rat brain. Exp. Neurol., 123, 295-302, 1993.

Lewis, M.E. Recent advances in neurobiology. Drug News and Perspectives, 6, 460-466, 1993.

Neff, N. T., Prevette, D., Houenou, L., Lewis, M. E., Glicksman, M. A., Yin, R.-W. and Oppenheim, R. W. Insulin-like growth factors: Putative muscle-derived trophic agents that promote motoneuron survival. J. Neurobiol., 24, 1578-1588, 1993.

Lewis, M. E., Neff, N. T., Contreras, P. C., Stong, D. B., Grebow, P. E. and Vaught, J. L. Insulin-like growth factor I: Potential for treatment of motor neuronal disorders. Exp. Neurol., 124, 73-88, 1993.

Contreras, P. C., Vaught, J. L., Gruner, J.A., Brosnan, C., Steffler, C. Arezzo, J.C., Lewis, M.E., Kessler, J.A. and Apfel, S.C., Insulin-like growth factor I prevents development of a vincristine neuropathy in mice. *Brain Res.* 774, 20-26, 1997.

BOOK CHAPTERS:

Stein, D.G. and Lewis, M.E.: Functional recovery after brain damage in adult organisms. In: Aspects of Neural Plasticity, F. Vital-Durand and M. Jeannerod, eds., INSERM, Paris, 203-228, 1975.

Goldman, P.S. and Lewis, M.E.: Developmental biology of brain damage and experience. In: Neuronal Plasticity, C.W. Cotman, ed., Raven Press, New York, 291-301, 1978.

Lewis, M.E.: Biochemical aspects of schizophrenia. In: Essays in Neurochemistry and Neuroparmacology, Vol. 4, M. B. H. Youdim, W. Lovenberg, D.F. Sharman, J.F. Lagnado, eds., John Wiley and Sons, New York, 1-67, 1980.

Akil, H., Watson, S.J., Young, E., Lewis, M.E., Khachaturian, H. and Walker, J.M.: Endogenous opioids: Biology and function. In: Annual Review of Neuroscience, Vol. 7, W. M. Cowan, ed., Annual Reviews, Inc., Palo Alto, 1984, pp. 223-255.

Lewis, J. W., Khachaturian, H., Lewis, M.E. and Akil, H.: Opioid peptides: Endogenous analgesics? In: Proceedings of the IX International Congress of Pharmacology, J.F. Mitchell, W. Paton and P. Turner, eds., Macmillan Press, Ltd., London, 1984, pp. 367-382.

Watson, S.J., Akil, H., Khachaturian, H., Young, E. and Lewis, M.E.: Opioid systems: Anatomical, physiological and clinical perspectives. In: Opioids: Past, Present and Future, H. O. J. Collier, J. Hughes, M.J. Rance and M. B. Tyers, eds., Taylor and Francis, Ltd., London, 1984, pp. 145-178.

Khachaturian, H., Lewis, M.E., Kang, T. and Watson, S.J.: Beta-endorphin and related peptides. In: Handbook of Chemical Neuroanatomy, Vol. 4, GABA and Neuropeptides in the CNS, part 1. A. Bjorklund and T. Hokfelt, eds., Elsevier Biomedical Publishers, Amsterdam, 1985, pp. 216-272.

Watson, S.J., Burke, S., Sherman, T.G., Lewis, M.E. and Akil, H. In situ hybridization: Localization of mRNA in endocrine and nervous tissue. In: Modern Neuroanatomical Methods, Society for Neuroscience Short Course Syllabus, Washington, D.C., 1985.

Davis, L.G., Lewis, M.E. and Baldino, F., Jr.: Synthetic oligodeoxyribonucleotide probe radiolabeling and in situ hybridization methodologies. In: In Situ Hybridization in Brain, G. Uhl, ed., Plenum Press, New York, 1986, pp. 230-232.

Khachaturian, H., Lewis, M.E., Does, R.M., Mansour, A., Akil, H. and Watson, S.J.: Comparative studies of proopiomelanocortin peptides in brain and pituitary. In: Central Actions of ACTH and Related Peptides, D. DeWeid and W. Ferrari,

eds., Liziana Press, Padova, Italy, 1986, pp. 15-31.

Lewis, M.E., Khachaturian, H., Schafer, M. K-H. and Watson, S.J.: Anatomical approaches to the study of neuropeptides and related mRNA in CNS. In Neuropeptides in Neurological Disease, ARNMD vol. 64, J. B. Martin and J. Barchas, eds., Raven Press, New York, 1986, 79-109.

Watson, S.J., Khachaturian, H., Lewis, M.E. and Akil, H.: Chemical neuroanatomy as a basis for biological psychiatry. In: American Handbook of Psychiatry, Vol. 8, P. A. Berger and H. K. H. Brodie, eds., Basic Books, Inc., New York, 1986, pp. 3-33.

Baldino, F., Jr., Chesselet, M.-F. and Lewis, M.E. High resolution in situ hybridization histochemistry. In: Methods in Enzymology: Hormone Action, Part L, Neuroendocrine Peptides, P. M. Conn, ed., Academic Press, New York, 1989, pp. 761-777.

Lewis, M.E., Krause, R.G., Rogers, W.T., and Schwaber, J.S. Quantitation and digital representation of in situ hybridization histochemistry. In: Methods in Enzymology: Hormone Action, Part L, Neuroendocrine Peptides, P. M. Conn, ed., Academic Press, New York, 1989, pp. 808-821.

Schwaber, J.S., Chronwall, B.M., and Lewis, M.E. Combining in situ hybridization histochemistry with retrograde tract-tracing. In: Methods in Enzymology: Hormone Action, Part L, Neuroendocrine Peptides, P. M. Conn, ed., Academic Press, New York, 1989, pp. 778-791.

Baldino, F., Jr., Chesselet, M.-F., and Lewis, M.E. High resolution in situ hybridization histochemistry. In: Neuroendocrine Peptide Methodology, P.M. ed., Academic Press, New York, 1989, pp. 79-95.

Lewis, M.E., Krause, R.G., Rogers, W.T. and Schwaber, J.S. Quantitation and digital representation of in situ hybridization histochemistry. In: Neuroendocrine Peptide Methodology, P.M. Conn, ed., Academic Press, New York, 1989, pp. 147-160.

Lewis, M.E. and Watson, S.J. Radioimmunocytochemistry: Review and methodology. In: Brain Imaging: Techniques and Applications, N.A. Sharif and M.E. Lewis, eds., Ellis Horwood Ltd., Chichester, 1989, pp. 209-219.

Baldino, F., Jr. and Lewis, M.E., Nonradioactive in situ hybridization histochemistry with digoxigenin-dUTP labeled oligonucleotides. In: Methods in Neuroscience, P.M. Conn, ed., Academic Press, New York, 1989, pp. 282-292.

Chronwall, B.M., Lewis, M.E., Schwaber, J.S., and O'Donohue, T.L. In situ hybridization combined with axonal tracing. In: Neuroanatomical Tract-tracing Methods, 2nd ed., L. Heimer and L. Zaborsky, eds., Plenum Press, New York, 1989, pp. 265-297.

Aloyo, V.J., Lewis, M.E. and Walker, R.F. Opioid peptide mRNAs in the rat pineal. In: The International Narcotics Research Conference (INRC) '89, Progress in Clinical and Biological Research, R. Quirion, K. Jhamandas, and C.

Gianoulakis, eds., A. R. Liss, Inc. New York, 1990, pp. 235-238.

Liu-Chen, L.-Y., Li, S., Rohrbach, K. W. and Lewis, M. E. [³H]Beta-Funaltrexamine ([³H] beta-FNA) binds irreversibly to mu opioid receptors in the rat brain: Autoradiographic study. In: The International Narcotics Research Conference, (INRC) '89, Progress in Clinical and Biological Research, R. Quirion, K. Jhamandas, and C. Gianoulakis, eds., A. R. Liss, Inc. New York, 1990, pp. 61-64.

Lewis, M. E. and Baldino, F., Jr., Probes for in situ hybridization histochemistry. In: In Situ Hybridization Histochemistry, M. -F. Chesselet, ed., CRC Press, Boca Raton, 1990, pp. 1-21.

Baldino, F., Jr., Robbins, E., Lewis, M.E. Messenger RNA detection in situ with digoxigenin-labeled synthetic oligonucleotide probes. In: C. Kessler, ed. Nonradioactive Labelling and Detection of Biomolecules. Springer-Verlag, Berlin, 1992, 367-373

Baldino, F., Jr., Roberts-Lewis, J. M. and Lewis, M. E., In situ hybridization histochemistry as a tool for the study of brain function. In: Current Aspects of the Neurosciences, Vol. 4, N. N. Osbourne, ed., Macmillan Publishers, Ltd., 1992, pp 1-32.

Khachaturian, H., Schafer, M. K. H., and Lewis, M.E., The structure and function of the endogenous opioid systems. In: Development of the Central Nervous System: Effects of Alcohol and Opiates, M. W. Miller, ed., Wiley-Liss, New York, 1992, pp. 209-219.

Khachaturian, H., Schafer, M. K. H., and Lewis, M. E., The anatomy and function of the endogenous opioid systems. In: Handbook of Experimental Pharmacology, A. Herz, ed., Springer-Verlag. Berlin, 1993, pp. 471-497.

Lewis, M. E. Robbins, E. and Baldino, F., Jr., In situ hybridization histochemistry with radioactive and non-radioactive cRNA and DNA probes. In: Molecular Imaging in Neuroscience: A Practical Approach, N. A. Sharif, ed., Oxford University Press, 1993, 1-22.

Baldino, F., Jr., Robbins, E. and Lewis, M.E. Enzyme histochemical detection of neuronal mRNA. In: In Situ Hybridization in Neurobiology, 2nd Ed., J. Eberwine, J.D. Barchas and K. Valentino, eds., Oxford Univ. Press, New York, 1994, 63-77.

MEETING ABSTRACTS AND PRESENTATIONS:

MacDonnell, P., Nagaiah, K., Lewis, M., Lakshmanan, J. and Guroff, G.: Effect of nerve growth factor on brain ornithine decarboxylase. Presented at the Ninth Annual Meeting of the American Society for Neurochemistry, Washington, D. C., March, 1978, and published in Trans. Am. Soc. Neurochem., 9: 210, 1978.

Avrith, D.B., Fitzsimons, J.T. and Lewis, M.E.: Intense sodium appetite after intracerebral injections of nerve growth factor. Presented at the Third European

Neurosciences Meeting, Rome, Italy, September, 1979, and published in Neuroscience Letters, Supplement 3, S 191, 1979.

Fitzsimons, J.T., Avrith, D.B. and Lewis, M.E.: Interrelation between nerve growth factor (NGF) and renin in thirst and sodium appetite. Presented at the Third European Neurosciences Meeting, Rome, Italy, September, 1979, and published in Neuroscience Letters, Supplement 3, S 327, 1979.

Lewis, M.E., Avrith, D.B. and Fitzsimons, J.T.: Short-latency, dose-dependent drinking following intracerebral microinjections of nerve growth factor (NGF). Presented at the Third European Neurosciences Meeting, Rome, Italy, September, 1979, and published in Neuroscience Letters, Supplement 3, S 195, 1979.

Lewis, M.E., Bragin, E., Mishkin, M., Pert, C.B. and Pert, A.: Differential distribution of type I and type II opiate receptors in monkey cerebral cortex. Presented at the Tenth Annual Meeting of the Society for Neuroscience, Cincinnati, Ohio, 1980 and published in Soc. Neurosci. Abstr., 6:360, 1980.

LeRoith, D., Shiloach, J., Roth, J., Liotta, A.S., Krieger, D.T., Lewis, M., Pert, C.B. and Goldstein, A.: Evolutionary origins of vertebrate hormones: Material very similar to ACTH, beta-endorphin and dynorphin in protozoa. Presented at the Ninety-Fourth Annual Meeting of the Association of American Physicians, San Francisco, California, April, 1980 and published in Clinical Research, 29: 566A, 1981.

Lewis, M.E., Pert, A., Pert, C.B. and Herkenham, M.: Laminar analysis of opiate receptor distribution in rat cerebral cortex. Presented at the Eleventh Annual Meeting of the Society for Neuroscience, Los Angeles, California, 1981, and published in Soc. Neurosci. Abstr., 7: 502, 1981.

Khachaturian, H., Lewis, M.E. and Watson, S.J.: Immunocytochemical studies with antisera against Leu-enkephalin and an enkephalin precursor fragment (BAM-22P) in the rat brain. Presented at the International Narcotics Research Conference, Falmouth, Massachusetts, June, 1982.

Lewis, M.E., Khachaturian, H. and Watson, S.J.: Visualization of opiate receptors and opioid peptides in sequential brain sections. Presented at the International Narcotics Research Conference, Falmouth, Massachusetts, June, 1982.

Khachaturian, H., Lewis, M.E., Holtt, V. and Watson, S.J.: Comparative brain distribution of enkephalin and an enkephalin precursor fragment. Presented at the Twelfth Annual Meeting of the Society for Neuroscience, Minneapolis, Minnesota, November, 1982, and published in Soc. Neurosci. Abstr., 8: 97, 1982.

Lewis, M.E., Khachaturian, H. and Watson, S.J.: Visualization of opiate receptors in relation to opioid peptide neuronal systems in brain and spinal cord. Presented at the Twelfth Annual Meeting of the Society for Neuroscience, Minneapolis, Minnesota, November, 1982, and published in Soc. Neurosci. Abstr., 8: 97, 1982.

Pamel, G. J., Lewis, M.E., Khachaturian, H. and Watson, S.J.: Dynorphin and [Leu] enkephalin immunocytochemistry in the guinea pig brain. Presented at the University of Michigan Student Medical Research Forum, Ann Arbor, Michigan, October, 1982.

Lewis, M.E., Khachaturian, H. and Watson, S.J.: Comparative distribution of opiate receptors and three opioid peptide neuronal systems in rhesus monkey central nervous system. Presented at the International Narcotic Research Conference, Garmisch-Partenkirchen, West Germany, June, 1983.

Khachaturian, H., Alessi, N.E., Lewis, M.E., Munfakh, N. and Watson, S.J.: Ontogeny of the opioid peptides in the rat brain and pituitary. Presented at the Thirteenth Annual Meeting of the Society for Neuroscience, Boston, Massachusetts, November, 1983, and published in Soc. Neurosci. Abstr., 9: 440, 1983.

Lewis, M.E., Khachaturian, H. and Watson, S.J.: Anatomical relationship of opiate receptors to beta-endorphin, enkephalin, and dynorphin-positive neuronal systems in rhesus monkey brain. Presented at the Thirteenth Annual Meeting of the Society for Neuroscience, Boston, Massachusetts, November, 1983, and published in Soc. Neurosci. Abstr., 9: 440, 1983.

Nelson, R., Friedman, D., O'Neill, J.B., Lewis, M.E., Mishkin, M. and Routtenburg, A.: Phosphorylation states of 45-49 k proteins in monkey cerebral cortex: Correspondence with opioid receptor gradients. Presented at the Thirteenth Annual Meeting of the Society for Neuroscience, Boston, Massachusetts, November, 1983, and published in Soc. Neurosci. Abstr., 9: 585, 1983.

Lewis, M.E., Khachaturian, H. and Watson, S.J.: Combined autoradiographic-immunocytochemical analysis of opiate receptors and opioid peptide neuronal systems in brain. Presented at the Fifth Annual Winter Neuropeptide Conference, Breckenridge, Colorado, January, 1984.

Khachaturian, H., Alessi, N.E., Lewis, M.E., Fitzsimmons, M. D. and Watson, S.J.: Development of hypothalamic opioid neurons: combined immunocytochemical and ³H-thymidine autoradiographic study. Presented at the International Narcotic Research Conference, Cambridge, England, July, 1984.

Lewis, J. W., Lewis, M.E. and Akil, H.: Brain opiate receptor occupation following in vivo administration of morphine. Presented at the International Narcotic Research Conference, Cambridge, England, July, 1984.

Lewis, M.E., Does, R.M. Khachaturian, H., Watson, S.J. and Akil, H.: Relationship between proportions of dynorphin A forms and opioid receptor subtypes in rat and guinea pig substantia nigra. Presented at the International Narcotic Research Conference, Cambridge, England, July, 1984.

Khachaturian, H., Lewis, M.E., Fitzsimmons, M.D. and Watson, S.J.: Immunocytochemical studies of dynorphin distribution in the rhesus monkey central nervous system. Presented at the Fourteenth Annual Meeting of the Society for Neuroscience, Anaheim, CA, October, 1984, and published in Soc. Neurosci. Abstr., 10, 1984.

Lewis, J.W., Lewis, M.E. and Akil, H.: Occupation of brain opiate receptors following in vivo administration of morphine. Presented at the Fourteenth Annual Meeting of the

Society for Neuroscience, Anaheim, California, October, 1984, and published in Soc. Neurosci. Abstr., 10, 1984.

Lewis, M.E., Burke, S., Sherman, T.G., Arentzen, R. and Watson, S.J.: In situ hybridization using a 3' terminal transferase-labelled synthetic oligonucleotide probe complementary to the alpha-MSH coding region of proopiomelanocortin messenger RNA. Presented at the Fourteenth Annual Meeting of the Society for Neuroscience, Anaheim, California, October, 1984, and published in Soc. Neurosci. Abstr., 10, 358, 1984.

Werz, M.A., Lewis, M.E., Watson, S.J. and MacDonald, R.L.: Heterogeneity of opioid receptors on dorsal root ganglion neurons in culture: A combined autoradiographic and electrophysiological study. Presented at the Fourteenth Annual Meeting of the Society for Neuroscience, Anaheim, California, October, 1984, and published in Soc. Neurosci. Abstr., 10, 585, 1984.

Dores, R.M., Lewis, M.E., Khachaturian, H., Watson, S.J. and Akil, H.: Differential processing of pro-dynorphin in the posterior pituitary and substantia nigra of the rat and the rhesus monkey. Presented at the Sixth Annual Winter Neuropeptide Conference, Breckenridge, Colorado, January, 1985.

Khachaturian, H., Lewis, M.E., Haber, S. N. and Watson, S.J.: Dynorphin immunocytochemistry in the rhesus monkey central nervous system. Presented at the Sixth Annual Winter Neuropeptide Conference, Breckenridge, Colorado, January, 1985.

Lewis M.E., Sherman, T.G. and Watson, S.J.: Synthetic oligodeoxynucleotides: A simple and specific route to in situ hybridization histochemistry? Presented at the Sixth Annual Winter Neuropeptide Conference, Breckenridge, Colorado, January, 1985.

Lewis, M.E., Lewis, M.S., Dores, R.M., Lewis, J.W., Khachaturian, H., Watson, S.J. and Akil, H.: Characterization of multiple opioid receptors and peptides in rat and guinea pig substantia nigra. Presented at the Twenty-ninth Annual Meeting of the Biophysical Society, Baltimore, Maryland, February, 1985, and published in Biophysical Journal, 47, 54a, 1985.

Khachaturian, H., Lewis, M.E., Dores, R.M., Akil, H. and Watson, S.J.: Comparative anatomy of pro-opiomelanocortin peptide systems. Presented at the Fourth Capo Boi Conference on Neuroscience, Villasimius, Sardinia (Italy), June, 1985.

Lewis, J.W., Lewis, M.E. and Akil, H. Estimation of brain opioid receptor occupation using in vivo and in vitro binding techniques. Presented at the International Narcotic Research Conference, Falmouth, Massachusetts, July, 1985.

Mansour, A., Lewis, M.E., Khachaturian, H. and Watson, S.J. Multiple opioid receptor subtypes differentiated by selective ligands. Presented at the International Narcotic Research Conference, Falmouth, Massachusetts, July, 1985.

Lewis, M.E.: In Situ cDNA-mRNA hybridization for neuropeptides. Presented at the INSERM Conference on Brain Imaging, Seillac, France, September, 1985.

Lewis, M.E., Burke, S., Sherman, T.G. and Watson, S.J.: Evaluating specificity in in situ

hybridization histochemistry. Presented at the Fifteenth Annual Meeting of the Society for Neuroscience, Dallas, Texas, October, 1985, and published in Soc. Neurosci. Abstr., 11, 141, 1985.

Mansour A., Lewis, M.E., Khachaturian, H. and Watson, S.J.: Autoradiographic differentiation of multiple opioid receptor subtypes with selective ligands. Presented at the Fifteenth Annual Meeting of the Society for Neuroscience, Dallas, Texas, October, 1985, and published in Soc. Neurosci. Abstr., 11, 1151, 1985.

Mansour, A., Lewis, M.E., Khachaturian, H., and Watson, S.J.: Multiple opioid receptor subtypes in the pituitary-adrenal axis: Across-species study. Presented at the International Narcotics Research Conference, San Francisco, CA, July, 1986.

Baldino, F., Jr., Card, J.P., and Lewis, M.E.: High resolution in situ hybridization histochemistry of somatostatin neurons. Presented at the Sixteenth Annual Meeting of the Society for Neuroscience, Washington, DC, November 1986, and published in Soc. Neurosci. Abstr., 12, 1396, 1986.

Lewis, M.E., Arentzen, R., and Baldino, F., Jr.: Radioiodinated synthetic oligonucleotides permit rapid, high resolution in situ hybridization histochemistry. Presented at the Sixteenth Annual Meeting of the Society for Neuroscience, Washington, DC, November 1986, and published in Soc. Neurosci. Abstr., 12, 1397, 1986.

Mansour, A., Lewis, M.E., Khachaturian, H., and Watson, S.J.: Multiple opioid receptor subtypes in the monkey. Presented at the Sixteenth Annual Meeting of the Society for Neuroscience, Washington, DC, November 1986, and published in Soc. Neurosci. Abstr., 12, 405, 1986.

Roberts-Lewis, J.M., Baldino, F., Jr., Krause, R., Chesselet, M.-F., Weiss, B., and Lewis, M.E.: In situ hybridization histochemistry of calmodulin mRNA in rat brain. Presented at the Sixteenth Annual Meeting of the Society for Neuroscience, Washington, DC, November 1986, and published in Soc. Neurosci. Abstr., 12, 1397, 1986.

Roberts-Lewis, J.M., Krause, R.G., II, Weiss, B., and Lewis, M.E.: Distribution of calmodulin mRNA in rat brain using in situ hybridization. Presented at the Seventy-first Annual FASEB Meeting, Washington, DC, March 1987, and published in Fed. Proc., 46, 397, 1987.

Lewis, M.E.: New molecular and cellular approaches to the study of neuropeptidergic systems and cardiovascular regulation. Presented at the FASEB Summer Research Conference on Neural Mechanisms in Cardiovascular Regulation, Saxtons River, Vermont, July, 1987.

Baldino, F., Jr., Deutch, A.Y., Roth, R.H., and Lewis, M.E.: In situ hybridization histochemistry of tyrosine hydroxylase messenger RNA in rat brain. Presented at the Seventeenth Annual Meeting of the Society for Neuroscience, New Orleans, Louisiana, November, 1987, and published in Soc. Neurosci. Abstr., 13, 1088, 1987.

Chronwall, B.M., Dubin, J. R., Krause, R.G., II, Lewis, M.E., and Schwaber, J.S.: Combination of fluorogold and rhodamine bead tract-tracing with in situ hybridization histochemistry. Presented at the Seventeenth Annual Meeting of the Society for

Neuroscience, New Orleans, Louisiana, November, 1987, and published in Soc. Neurosci. Abstr., 13, 676, 1987.

Dores, R.M., Krause, R.G., II, and Lewis, M.E.: Physiological induction of proopiomelanocortin mRNA in the frog pituitary. Presented at the Seventeenth Annual Meeting of the Society for Neuroscience, New Orleans, Louisiana, November, 1987, and published in Soc. Neurosci. Abstr., 13, 1284, 1987.

Lewis, M.E., Tyrrell, D.F., Jr., Roberts-Lewis, J.M., Weiss, B., Manning, R. W., and Davis, L.G.: Isolation of cDNA clones encoding rat brain calmodulin. Presented at the Seventeenth Annual Meeting of the Society for Neuroscience, New Orleans, Louisiana, November, 1987, and published in Soc. Neurosci. Abstr., 13, 560, 1987.

Rogers, W.T., Schwaber, J.S., and Lewis, M.E.: Computer-aided analysis of cellular resolution in situ hybridization histochemistry in brain. Presented at the Seventeenth Annual Meeting of the Society for Neuroscience, New Orleans, Louisiana, November, 1987, and published in Soc. Neurosci. Abstr., 13, 1088, 1987.

Lewis, M.E.: In situ hybridization histochemistry with synthetic oligonucleotides: Methodological and quantitative issues. Presented at the Philadelphia Chapter of the Society for Neuroscience Meeting, "In Situ Hybridization: Potentials of a New Technique", December, 1987.

Weiss, B., Cimino, M., Roberts-Lewis, J. and Lewis, M.E.: Development and regulation of calmodulin mRNA in rat brain using in situ hybridization histochemistry. Presented at the NIMH Conference on Molecular Neurobiology, 1988, and published in Molecular Neurobiology - Proceedings of the First NIMH Conference, DHHS Pub. No. (ADM) 89-1619, 347, 1989.

Christoph, G.R., Burkhardt, B., Krause, R.G., Angulo, G., Lewis, M.E. and Davis, L.G.: Reduction of dopaminergic input increases the expression of the enkephalin gene. Presented at the Eighteenth Annual meeting of the Society for Neuroscience, Toronto, Canada, November, 1988, and published in Soc. Neurosci. Abstr., 14, 1075, 1988.

Ingram, S.M., Krause, R.G., Baldino, F., Jr., Skeen, L. C. and Lewis, M.E.: Neuronal localization of cholecystokinin mRNA in rodent brain with in situ hybridization histochemistry. Presented at the Eighteenth Annual meeting of the Society for Neuroscience, Toronto, Canada, November, 1988, and published in Soc. Neurosci. Abstr., 14, 668, 1988.

Baldino, F., Jr. and Lewis, M.E.: Current perspectives on in situ hybridization histochemistry as a tool to study CNS function. Presented at the Tenth Annual Winter Neuropeptide Conference, Breckenridge, Colorado, January, 1989.

Aloyo, V.J., Lewis, M.E. and Walker, R.F.: Rat pineal glands contain POMC-mRNA. Presented at the 73rd Annual FASEB meeting, New Orleans, Louisiana March, 1989, and published in The FASEB Journal 3, A729, 1989.

Liu-Chen, L.-Y., Li, S., Rohrbach, K.W. and Lewis, M.E.: Autoradiographic evidence that [³H]beta-funaltrexamine ([³H]beta-FNA) binds irreversibly to mu opioid receptors

in the rat brain. Presented at the Seventy-third Annual FASEB meeting, New Orleans, Louisiana March, 1989, and published in The FASEB Journal 3, A589, 1989.

Springer, J.E., Lewis, M.E., Robbins, E., Meyer, S. and Baldino, F., Jr.: Effects of NGF removal on NGF-receptor gene expression in the rat basal forebrain. Presented at the National Institute on Aging Conference on Molecular and Cellular Mechanisms of Neuronal Plasticity in Aging and Alzheimer's Disease, Bethesda, Maryland, May, 1989.

Aloyo, V.J., Lewis, M.E. and Walker, R.F.: Opioid peptide mRNAs in the rat pineal. Presented at the International Narcotics Research Conference, Montreal, Canada, July, 1989.

Liu-Chen, L.-Y., Li, S., Rohrbach, K.W. and Lewis, M.E.: [³H] Beta-funaltrexamine ([³H] beta-FNA) binds irreversibly to my opioid receptors in the rat brain: Autoradiographic study. Presented at the International Narcotics Research Conference, Montreal, Canada, July, 1989.

Baldino, F., Jr., Robbins, E., Grega, D., Meyer, S.L., Springer, J.E. and Lewis, M.E.: Nonradioactive detection of NGF receptor mRNA with digoxigenin-UTP labeled RNA probes. Presented at the 19th Annual Meeting of the Society for Neuroscience, Phoenix, Arizona, November, 1989, and published in Soc. Neurosci. Abstr. 15, 864, 1989.

Grega, D.S., Cavanaugh, T.J., Grimme, S., Martin, R., Lewis, M., Robbins, E., and Baldino, F., Jr.: Localization of neuronal mRNA by in situ hybridization histochemistry using a nonradioactive detection method. Presented at the 19th Annual Meeting of the Society for Neuroscience, Phoenix, Arizona, November, 1989, and published in Soc. Neurosci. Abstr. 15, 739, 1989.

Krieder, M.S., Lewis, M.E., Baldino, F., Jr. and Winokur, A.: Systemic kainic acid increases TRH prohormone mRNA expression in rat CNS. Presented at the 19th Annual Meeting of the Society for Neuroscience, Phoenix, Arizona, November, 1989, and published in Soc. Neurosci. Abstr. 15, 1252, 1989.

Springer, J.E., Lewis, M.E., Robbins, E., Meyer, S., and Baldino, F., Jr.: Fimbria-fornix transections influence NGF-receptor gene expression in the rat basal forebrain. Presented at the 19th Annual Meeting of the Society for Neuroscience, Phoenix, Arizona, November, 1989, and published in Soc. Neurosci. Abstr. 15, 707, 1989.

Lewis, M. E., Robbins, E., Meyer, S. L. and Grega, D. S.: Quantitative, non-radioactive detection of preproenkephalin mRNA with digoxigenin-UTP labeled cRNA probes. Presented at the 20th Annual Meeting of the Society for Neuroscience, St. Louis, Missouri, October-November, 1990, and published in Soc. Neurosci. Abstr. 16, 349, 1990.

Meyer, S. L., Sekhon, H., Mudd, R., Siman, R., Friedman, C.A.H., Callison, K. V., Kish, A., Vissavajhala, Ross, A. H. and Lewis, M. E.: Production and characterization of human recombinant NGF. Presented at the 20th Annual Meeting of the Society for Neuroscience, St. Louis, Missouri, October-November, 1990, and published in Soc. Neurosci. Abstr. 16, 481, 1990.

Roberts-Lewis, J.M., DiCocco, C., Meyer, S.L., Lewis, M.E., and Siman, R.: Proteolysis of brain spectrin precedes the degeneration of septal neurons following fimbria-fornix transection. Presented at the 20th Annual Meeting of the Society for Neuroscience, St. Louis, Missouri, October-November, 1990, and published in Soc. Neurosci. Abstr. 16, 983, 1990.

Smith, K.R. and Lewis, M.E.: Quantitative analysis of insulin-like growth factor-I using a radioreceptor assay. Presented at the 5th Annual Meeting of the American Association of Pharmaceutical Scientists, Las Vegas, Nevada, November, 1990, and published in Pharmaceut. Res. 7, S-47, 1990.

Hoffman, E.K., Lewis, M.E., Clopton, K. and Carswell, S.: Induction of NGF occurs by multiple mechanisms. Presented at the 21st Annual Meeting of the Society for Neuroscience, New Orleans, Louisiana, November 1991, and published in Soc. Neurosci. Abstr. 17, 1991.

Robbins, E., Lewis, M. E., Reilly E. M. and Baldino, F., Jr.: Non-radioactive solution hybridization of brain mRNA. Presented at the 21st Annual Meeting of the Society for Neuroscience, New Orleans, Louisiana, November, 1991, and published in Soc. Neurosci. Abstr. 17, 1991.

Seeburger, J. D., Tarras, S., Lewis, M. E., Robbins, E. and Springer, M. E.: The expression of nerve growth factor receptor and heat shock protein mRNA in ALS spinal cord. Presented at the 21st Annual Meeting of the Society for Neuroscience, New Orleans, Louisiana, November 1991, and published in Soc. Neurosci. Abstr. 17, 1991.

Hoffman, E.K., Wilcox, H.M., Hartpence, K.C., Lewis, M.E. and Carswell, S.: Structural and functional characterization of the mouse nerve growth factor promoter region. Presented at "Advances in Understanding Neurodegenerative Disorders", Big Sky, Montana, April 1992.

Lewis, M.E., Robbins, E., Riley, E., Marcy, V., Roberts-Lewis, J.M., Baldino, F., Jr. and Springer, J.E.: Non-radioactive in situ hybridization with digoxigenin-labeled cRNA and oligonucleotide probes. Presented at the 43rd Annual Meeting of the Histochemical Society, Bethesda, MD, May 1992 and published in J. Histochem Cytochem. 40, 595, 1992.

Lewis, M.E.: Preclinical studies of IGF-I for the treatment of neuromuscular disorders. Presented at "Amyotrophic Lateral Sclerosis, 1992: Research and Therapy", Houston, TX, October 1992.

Carswell, S., Wilcox, H., Clopton-Hartpence, K., Saporito, M.S., Lewis, M.E. and Vaught, J.L.: Multiple cellular pathways of induction of NGF by 1,25 dihydroxyvitamin D3, TPA, serum, and 4-methylcatechol. Presented at the 22nd Annual Meeting of the Society for Neuroscience, Anaheim, CA, October, 1992, and published in Soc. Neurosci. Abstr., 18, 777, 1992.

Hoffman, E.K., Saporito, M.S., Wilcox, H.M., Hartpence, K.C., Lewis, M.E. and Carswell, S.: Molecular mechanisms of nerve growth factor induction by 4-methylcatechol. Presented at the 22nd Annual Meeting of the Society for Neuroscience, Anaheim, CA, October, 1992, and published in Soc. Neurosci. Abstr., 18, 777, 1992.

Lewis, M.E., Callison, K.V. and Neff, N.: Is K252a a non-competitive partial agonist of high affinity NGF receptors? Presented at the 22nd Annual Meeting of the Society for Neuroscience, Anaheim, CA, October, 1992, and published in Soc. Neurosci Abstr., 18, 13, 1992.

Roberts-Lewis, J.M., Marcy, V.R., Zhao, Y., Fedora, T., Lewis, M.E., Siman, R. and Vaught, J.L.: The apoptosis inhibitor, aurintricarboxylic acid prevents excitotoxin-induced neuronal death in vivo. Presented at the 22nd Annual Meeting of the Society for Neuroscience, Anaheim, CA, October, 1992, and published in Soc. Neurosci Abstr., 18, 44, 1992.

Saporito, M.S., Hartpence, K.C., Reilly, E.M., Robbins, E., Steffler, C., Wilcox, H.M., Vaught, J.L., Lewis, M.E. and Carswell, S.: Pharmacological induction of nerve growth factor mRNA in adult rat brain. Presented at the 22nd Annual Meeting of the Society for Neuroscience, Anaheim, CA, October, 1992, and published in Soc. Neurosci Abstr., 18, 777, 1992.

Vaught, J.L., Lewis, M.E., Saporito, M.S., Wilcox, H., Clopton-Hartpence, K. and Carswell, S.: Correlation of pharmacological induction of NGF *in vivo* and *in vitro*. Presented at the 22nd Annual Meeting of the Society for Neuroscience, Anaheim, CA, October, 1992, and published in Soc. Neurosci Abstr., 18, 777, 1992.

Lewis, M.E., Vaught, J.L., Grebow, P.E. and Baldino, F.: The potential of IGF-I as a therapeutic for the treatment of neuromuscular disorders. Presented at "The Role of Insulin-Like Growth Factors in the Nervous System", The New York Academy of Sciences, Arlington, VA, November, 1992.

Lewis, M.E.: IGF-I: Preclinical and clinical investigations. Presented at the 19th European Neuromuscular Center Meeting, "Neurotrophic Factors and Motor Neuron Disease", Naarden, The Netherlands, January, 1993.

Lewis, M.E.: IGF-I preclinical studies. Presented at "Therapeutic Trials in Spinal-Muscular Atrophy," Cambridge, MA, May, 1993.

Contreras, P.C., Steffler, C., Dennis, S., Arezzo, J.C., Lewis, M.E., Apfel, S.C., Kessler, J.A., Gruner, J.A. and Vaught, J.L. Recombinant human insulin-like growth factor-I (IGF-I) prevents development of vincristine-induced neuropathy in mice. Presented at the 23rd Annual Meeting of the Society for Neuroscience, Washington, D.C., November, 1993, and published in Soc. Neurosci Abstr., 19, 1105, 1993.

Lewis, M.E., Vaught, J.L., Carswell, S., Lapchak, P.A., Brown, E.R., Hartpence, K.C., Wilcox, H.M., and Saporito, M.S.: 1,25 dihydroxyvitamin D3-mediated induction of nerve growth factor mRNA and protein in L929 fibroblasts and in vivo. Presented at the 23rd Annual Meeting of the Society for Neuroscience, Washington, D.C., November, 1993, and published in Soc. Neurosci Abstr., 19, 257, 1993.

Lewis, M.E.: Neurotrophic factors: Current and future therapeutic directions. Presented at the Fourth Annual Symposium of the Pennsylvania Biotechnology Association, April, 1994.

PUBLISHED ANALYST REPORTS (for Pennsylvania Merchant Group Ltd):

BioTime, Inc. (BTIM), 1996

Cephalon, Inc. (CEPH), 1996, 1997

Cypros Pharmaceutical Corp. (CYPR), 1996

Guilford Pharmaceuticals, Inc. (GLFD), 1996

North American Vaccine, Inc. (NVX), 1996

Pharmos Corporation (PARS), 1995, 1996

Texas Biotechnology Corp. (TXB), 1997